INPHOMIR

INdium PHOsphide-based advanced Monolithically integrated photonic building-blocks at near and mid-InfraRed wavelengths

Project Information:

Project Full Title

Indium PHOsphide-based advanced Monolithically integrated photonic building-blocks at near and mid-InfraRed wavelengths

Project Acronym

INPHOMIR

Grant Agreement Number

101135749

Topic

HORIZON-CL4-2023-DIGITAL-EMERGING-01-51

EU Contribution

4.999.637,50

Duration

42 months

Project Coordinator

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Project Website

www.inphomir.eu

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INPHOMIR: Pioneering the Future of Navigation with Advanced Photonic Technologies

The European Union-funded project **INPHOMIR** has launched under the Horizon Europe programme, setting the stage for a technological breakthrough in **navigation and sensing systems**.

INPHOMIR (INdium PHOsphide-based advanced Monolithically integrated photonic building-blocks at near and mid-InfraRed wavelengths) aims to develop a **new generation of compact, highly efficient, and precise photonic sensors** based on **indium phosphide (InP) photonic integrated circuits (PICs)**. These sensors will enable **inertial navigation systems (INS)** that operate with exceptional accuracy — even in **GPS-denied environments**, such as deep space, underwater, and contested areas.

Addressing Today's Navigation Challenges

Current navigation technologies often rely heavily on GPS, making them vulnerable to signal loss or jamming. Additionally, existing high-precision inertial sensors are typically **bulky, expensive, and power-hungry**.

INPHOMIR aims to overcome these limitations by creating **monolithic integrated photonic solutions**, which combine **miniaturization, robustness, and energy efficiency**. This innovation will open new frontiers in:

- **Satellite and space navigation**
- **Autonomous vehicles and robotics**
- **Defense and security systems**
- **Aerial and underwater navigation**

Key Results so far

So far, INPHOMIR has achieved significant technical progress in the design, simulation, and initial fabrication of innovative photonic components for both the near-infrared (NIR) and mid-infrared (MIR) platforms.

On the NIR side, the team has developed and simulated **advanced high-Q resonators**, such as **optically compensated spiral resonators (OC-SR)** and **photonic crystal ring resonators (PhC-RR)**, which are key to achieving high sensitivity in compact devices.

For the MIR platform, researchers have designed **narrow-linewidth quantum cascade lasers (QCLs)** and **balanced heterodyne quantum cascade detector (QCD) PICs**, paving the way for highly accurate sensing in challenging environments.

In addition, **preliminary designs** have been completed for two flagship devices:

- a **fully-integrated optical gyroscope** operating in the NIR range
- a **frequency-modulated continuous-wave (FMCW) LiDAR PIC** for the MIR range.

The consortium has also advanced in building a **library of ultra-low-loss PIC components** for both NIR and MIR. This includes:

- **first fabrication results** for OC-SR resonators with integrated distributed semiconductor optical amplifiers
- **new doping-compensated passive InGaAs/InP waveguides** with exceptionally low optical losses — around 0.1 dB/cm at 4.5 µm and 0.8 dB/cm at 8.5 µm
- **waveguide-coupled QCLs, QCDs, and QCLDs** operating within the 4.5–9 µm wavelength range.

These developments lay the technological foundation for the next generation of compact, precise, and robust photonic sensors for inertial navigation systems.

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A Strong European Consortium

The project brings together **9 leading partners from across Europe**, including top-tier universities, research institutes, and industrial leaders. Coordinated by **GEM ELETTRONICA (Italy)**, the consortium combines complementary expertise in **photonics, navigation systems, microelectronics, and system integration**, ensuring a holistic approach from design to application.

Expected Impacts

- Development of **novel InP-based building blocks** for near- and mid-infrared photonic integration
- Fabrication and packaging of **next-generation photonic gyroscopes and LiDAR systems**
- Demonstration of fully integrated modules for **aerospace and defense applications**
- Strengthening Europe's leadership in **advanced photonics for navigation and sensing**

Partners:

GEM ELETTRONICA (Italy)**, Politecnico di Bari** (Italy), **Sigma Ingegneria** (Italy), **Tinexta Innovation Hub / BeWarrant** (Belgium), **Eindhoven University of Technology** (Netherlands), **Technical University of Munich** (Germany), **University College Cork** (Ireland), and **EnduroSat AD** (Bulgaria)

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